

REMARKS

Upon entry of this Amendment, claims 1-39 are all the claims pending in the application. Claims 38 and 39 have been added. Claims 1-37 have been rejected. Applicant thanks the Examiner for acknowledging acceptance of the drawings filed December 6, 2001.

Summary of the Office Action

In the office action, claims 3, 5, 20-22 and 24-29 were rejected under 35 U.S.C. § 112, second paragraph, and claim 6 was objected to for improper antecedence. Also, claims 1, 8, 13-31, 33, 36 and 36 were rejected under 35 U.S.C. § 102(b) as being anticipated by Teramae et al. (EP 1 023 997); Claims 1-7, 9, 13, 14, 16, 17, 31, 34, 35 and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Anderson et al. (USP 6,116,717) in view of Nagoshi et al. (USP 6,224,182); and Claims 10-12 and 32 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Anderson et al. (USP 6,116,717) in view of Nagoshi et al. (USP 6,224,182) as applied to claims 9 and 17, and further in view of Ujita et al. (USP 5,506,611).

For the reasons set forth below in regard to each of the rejections, Applicant respectfully traverses the rejections and requests favorable disposition of the application.

§112, second paragraph, Rejection

In response to the rejection of claims 3, 5, 20-22 and 24-29 under 35 U.S.C. §112, second paragraph, Applicant has amended the claims as set forth in the attached Appendix. Applicant submits that all of the claims of the present application satisfy each of the provisions of 35 U.S.C. §112. Withdrawal of the rejection under §112, second paragraph, is therefore requested.

Prior Art Rejections

Present Invention

The present invention is directed to a method of manufacturing an ink jet recording head and an ink jet recording head manufactured by the method. To enable suitable suppression of meniscus vibration in the recording head, even when the natural period of ink in the pressure chamber varies, the present application discloses and claims a method whereby the natural period of the ink pressure fluctuation is measured in each recording head and the recording heads are then classified into ranks based on the measured natural period of each recording head. In particular, independent claim 1 recites, *inter alia*;

measuring a natural period of the ink pressure fluctuation in the pressure chamber of the assembled recording head; and
classifying the assembled recording head into a plurality of ranks, based on the measured natural period.

§102 Rejection over Teramae

The Examiner asserts that the features set forth in claims 1, 8, 13-31, 33, 35 and 36 are anticipated by Teramae. For at least the following reasons, Applicant submits that the claims patentably distinguish over the prior art.

Claim 1 requires that the natural period of the ink pressure fluctuation be *based on a plurality of measurements*. Teramae does not teach or suggest this feature. Therefore, claim 1 is not anticipated by the teachings of Teramae and the §102 rejection of claim should be withdrawn.

Additionally, the Examiner asserts that the classifying step of claim 1 is disclosed in Teramae at column 16, lines 16-24. Applicant respectfully disagrees because even though

Teramae discloses measuring “a natural period Ta” and a “natural period Tc” (see col. 14, line 58 through col. 15, line 15), Teramae does not disclose “classifying” the recording heads into ranks based on the measured natural period(s), as recited by claim 1. Instead, as disclosed at column 14, line 13 through column 16, line 27, Teramae discloses measuring natural periods Ta and Tc, as shown in figure 8, and subsequently applying an ID number corresponding to a particular *ejection period*, and a different ID number corresponding to a particular *contraction holding period*, to the recording head. As shown in figure 9A, each of the different ejection period ID numbers corresponds to an ejection period between 3.5 μ s and 4.5 μ s, each ejection period being differentiated from the next ejection period by a 0.1 μ s step. Similarly, as shown in figure 9B, each of the different contraction period ID numbers corresponds to a contraction period between 3.1 μ s and 6.1 μ s, each contraction period being differentiated from the next contraction period by a 0.2 μ s step.

Therefore, instead of *classifying the recording heads into ranks, based on a measured natural period of the ink pressure fluctuation in the pressure chamber of the recording head*, Teramae discloses a method of applying different ID numbers, and thus a different corresponding time duration, to different portions of the drive signal.

Accordingly, in view of the arguments set forth above, Teramae does not anticipate claim 1 or any claims dependent thereon, specifically, claims 2-16 and 30. Furthermore, for similar reasons, Teramae does not anticipate claim 17, claim 35 or any claims dependent on these two claims, specifically, claims 18-29, 31-34 and 36-37, respectively.

§103 Rejection over Anderson et al. and Nagoshi et al.

The Examiner asserts that the features set forth in claims 1-7, 9, 13, 14, 16, 17, 31, 34, 35 and 37 are rendered obvious by the combination of Anderson et al. and Nagoshi et al. For at least the following reasons, Applicant submits that the rejected claims are not rendered obvious by the proposed combination of references.

Claim 1 requires that the natural period of the ink pressure fluctuation be *based on a plurality of measurements*. Neither of the cited references, Anderson et al. or Nagoshi et al. teaches or suggests this feature. Therefore, claim 1 is not rendered obvious by the combined teachings of Anderson et al. and Nagoshi et al. and the §103 rejection should be withdrawn.

Additionally, the present claims recite, for example in claim 1, *measuring a natural period of the ink pressure fluctuation*. The Examiner asserts that, although using different terminology, Anderson et al. describes this feature at column 4, line 54 through column 5, line 34. Applicant respectfully disagrees with the examiner at least because what is being measured in the cited passage of Anderson et al. is not the natural period of the ink pressure fluctuation. Anderson et al. discloses measuring the mass of ejected ink (col. 4, line 66 through col. 5, line 14) and measuring the ink velocity of ejected droplets (col. 5., lines 23-34). However, these two measurements alone do not comprise a measurement of the natural period, as claimed. Instead, these two measurements, ink mass and ink velocity, are used in Anderson et al. to build second and third offset tables, respectively. A first offset table is built based on resistance measurements of the array of heater elements. (See col. 4, line 30 through col. 5, line 45 and Figs. 3 and 4). The three offset tables are then used together to control the drive signal to the print head.

To the contrary, in the claimed invention either measured ink volume or measured ink velocity can be used to determine the natural period of the recording head. However, either measurement alone is insufficient to determine the natural period. As disclosed on page 22, line 17 through page 28, line 12 and illustrated in figure 6, the natural period of a recording head is measured by comparing various ink weights that result from different pulsewidths. Additionally, at page 28, line 18 through page 30, line 4, a method of measuring the natural period based on the ink velocity is disclosed.

Anderson et al. discloses a method in which various offset tables are determined based on resistance values of the heater elements, ink volume and ink velocity, respectively. The offset tables are used to control the drive signal to the recording head. Nowhere in Anderson et al. is it disclosed to measure the natural period of the recording head. Nagoshi et al. also fails to disclose this claimed feature. Accordingly, the proposed combination of Anderson et al. and Nagoshi et al. does not teach or suggest all the limitations of the claims.

For at least the above reason the §103 rejection of claims 1-7, 9, 13, 14, 16, 17, 31, 34, 35 and 37 should be withdrawn.

§103 Rejection over Anderson et al., Nagoshi et al. and Ujita et al.

The Examiner asserts that the features set forth in claims 10-12 and 32 are rendered obvious by the combination of Anderson et al., Nagoshi et al. and Ujita et al. Because Ujita et al. fails to compensate for the above-described deficiencies of Anderson et al. and Nagoshi et al., for at least the same reasons as set forth above in regard to claims 1 and 17, upon which claims 10-

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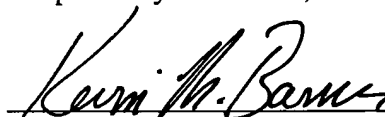
12 and 32 depend, respectively, the proposed combination of Anderson et al., Nagoshi et al. and Ujita et al. fails to render claims 10-12 and 32 obvious.

Conclusion

In view of the foregoing amendments and remarks, the application is believed to be in form for immediate allowance with claims 1-39, and such action is hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, he is kindly requested to **contact the undersigned** at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The claims are amended as follows:

1. (Amended) A method of manufacturing an ink jet recording head which includes a plurality of nozzle orifices forming at least one nozzle row, pressure chambers each communicated with the associated nozzle orifice, pressure generating elements each generating pressure fluctuation in ink provided in the associated pressure chamber to eject an ink droplet from the associated nozzle orifice, the method comprising the steps of:

assembling the ink jet recording head;

[measuring] identifying a natural period of the ink pressure fluctuation in the pressure chamber of the assembled recording head based on a plurality of measurements; and

classifying the assembled recording head into a plurality of ranks, based on the measured natural period.

2. (Amended) The manufacturing method as set forth in claim 1, wherein the

[measuring] identifying step includes the steps of:

supplying an evaluation signal including at least an excitation element which excites the ink pressure fluctuation, and an ejection element which follows the excitation element to eject the ink droplet from the nozzle orifice;

measuring an ejected amount of the ink droplet at plural times while varying a time period between a termination end of the excitation element and an initial end of the ejection element; and

identifying the natural period based on a correlation between the time period and the measured ink amount.

3. (Amended) The manufacturing method as set forth in claim 2, wherein the time [interval] period includes at least:

a first time period which is determined such that the ejected ink amount becomes minimum when the natural period is as per a designed criterion;

a second time period which is shorter than the first time period; and

a third time period which is longer than the first time period.

5. (Amended) The manufacturing method as set forth in claim 4, wherein the time [interval] period includes at least:

a first time period which is determined such that the ejection speed becomes minimum when the natural period is as per a designed criterion;

a second time period which is shorter than the first time period; and

a third time period which is longer than the first time period.

6. (Amended) The manufacturing method as set forth in claim 2 [or 4], wherein duration of the excitation element is equal to the natural period as per [the] a designed criterion or less.

19. (Amended) The recording apparatus as set forth in claim 17, wherein the drive signal is provided with a [first] drive pulse including:

[a first] an expansion element, which expands the pressure chamber such an extent that an ink droplet is not ejected from the nozzle orifice;

[a first] an ejection element, which follows the [first] expansion element to contract the pressure chamber to eject an ink droplet from the nozzle orifice;

a holding element, which follows the [first] ejection element to hold the contracted state of the pressure chamber for a predetermined duration; and

[a first] damping element, which follows the holding element to expand the pressure chamber to damp vibration of a meniscus of the ink in the nozzle orifice; and

wherein the waveform controller defines the duration of the holding element.

20. (Amended) The recording apparatus as set forth in claim 17, wherein the drive signal is provided with a [second] drive pulse including:

[a second] an expansion element, which expands the pressure chamber to pull a meniscus of ink in the nozzle orifice toward the pressure chamber;

[a second] an ejection element, which follows the [second] expansion element to contract the pressure chamber to eject a center portion of the meniscus as an ink droplet; and

a [second] damping element, which follows the [second] ejection element to expand the pressure chamber to damp vibration of the meniscus; and

wherein the waveform controller defines the duration of the [second] damping element.

21. (Amended) The recording apparatus as set forth in claim 17, wherein the drive signal is provided with a [third] drive pulse including:

an ejection pulse, which ejects an ink droplet from the nozzle orifice;

a damping pulse, which follows the ejection pulse to damp vibration of a meniscus of ink in the nozzle orifice; and

a [first] connecting element, which connects a termination end of the ejection pulse and an initial end of the damping pulse; and

wherein the waveform controller defines duration of the connecting element.

22. (Amended) The recording apparatus as set forth in claim 17, wherein the drive signal is provided with a plurality of drive pulses for driving the pressure generating element and a [second] connecting element which connects a termination end of a preceding drive pulse and an initial end of a subsequent drive pulse; and

wherein the waveform controller defines duration of the second connecting element.

24. (Amended) The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a [fourth] drive pulse including:

[a first] an expansion element, which expands the pressure chamber such an extent that an ink droplet is not ejected; and

[a first] an ejection element, which follows the [first] expansion element to contract the pressure chamber to eject an ink droplet from the nozzle orifice; and

wherein duration of at least one of the first expansion element and the first ejection element is defined by the waveform controller.

25. (Amended) The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a [fourth] drive pulse including:

[a first] an expansion element, which expands the pressure chamber such an extent that an ink droplet is not ejected; and

[a first] an ejection element, which follows the [first] expansion element to contract the pressure chamber to eject an ink droplet from the nozzle orifice; and

wherein a potential difference between an initial end and a termination end of at least one of the [first] expansion element and the [first] ejection element is defined by the waveform controller.

26. (Amended) The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a [fifth] drive pulse including:

[a first] an expansion element, which expands the pressure chamber such an extent that an ink droplet is not ejected;

a [first] holding element, which follows the [first] expansion element to hold the expanded state of the pressure chamber; and

[a first] an ejection element, which follows the [first] expansion element to contract the pressure chamber to eject an ink droplet from the nozzle orifice; and

wherein the waveform controller defines duration of the [first] holding element.

27. (Amended) The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a [sixth] pulse including:

[a second] an expansion element, which expands the pressure chamber to pull a meniscus of ink in the nozzle orifice toward the pressure chamber; and

[a second] an ejection element, which follows the [second] expansion element to contract the pressure chamber to eject a center portion of the meniscus as an ink droplet; and

wherein duration of at least one of the [second] expansion element and the [second] ejection element is defined by the waveform controller.

28. (Amended) The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a [sixth] drive pulse including:

[a second] an expansion element, which expands the pressure chamber to pull a meniscus of ink in the nozzle orifice toward the pressure chamber; and

[a second] an ejection element, which follows the [second] expansion element to contract the pressure chamber to eject a center portion of the meniscus as an ink droplet; and

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wherein a potential difference between an initial end and a termination end of at least one of the [second] expansion element and the [second] ejection element is defined by the waveform controller.

29. (Amended) The recording apparatus as set forth in claim 23, wherein the drive signal is provided with a [seventh] drive pulse including:

[a second] an expansion element, which expands the pressure chamber to pull a meniscus of ink in the nozzle orifice toward the pressure chamber;

a [second] holding element, which follows the [second] expansion element to hold the expanded state of the pressure chamber; and

[a second] an ejection element, which follows the [second] holding element to contract the pressure chamber to eject a center portion of the meniscus as an ink droplet; and

wherein the waveform controller defines duration of the [second] holding element.

35. (Amended) A ink jet recording head, manufactured by the method as set forth in any one of claims 1 to 13, 38 or 39.

Claims 38 and 39 are added as new claims.